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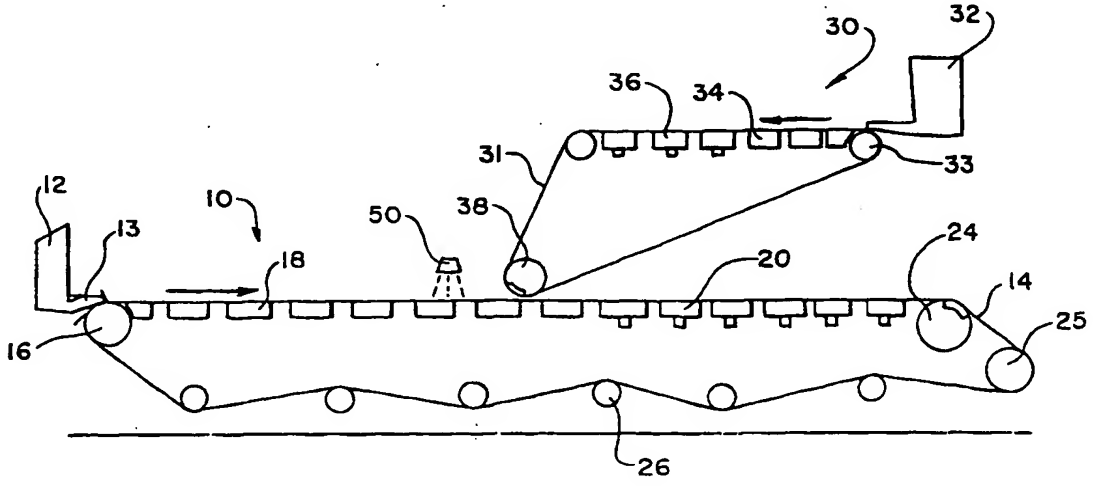

(57) Abstract

A moisture barrier paper is comprised of a fiber mat and a unique moisture barrier coating (50). The moisture barrier coating (50) coats substantially every fiber throughout the fiber mat. The moisture barrier paper is created in a wet-end (10), on-machine process where a liquid, moisture barrier coating (50) is sprayed onto a forming fiber mat and is drawn through the fibers with vacuum boxes (20). The moisture barrier paper has top and bottom surfaces that are substantially free of wax and polymeric water repellents. The moisture barrier paper is completely repulpable.

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MOISTURE BARRIER PAPER AND PROCESS FOR MAKING THE SAME

CLAIM TO PRIORITY

The present application claims priority to United States provisional application having serial number 60/071,647, filed January 16, 1998.

FIELD OF THE INVENTION

The present invention relates to a moisture barrier paper and more particularly to a moisture barrier paper that is repulpable, recyclable, and that is created by a wet-end on-machine process.

BACKGROUND OF THE INVENTION

Linerboard, new production or recycled, may be used to make corrugated packaging materials (hereafter, "corrugated"). Corrugated has numerous applications including packaging or containing various materials that may have a moisture content. In a moisture content situation, it is essential that the corrugated incorporate a moisture barrier to prevent, or at least slow, the leakage of any moisture.

Currently, approximately twenty-five percent of all corrugated is treated to produce an end-product having a moisture barrier. Conventional methods of creating moisture barrier products include: (1) coating linerboard with a polymeric water-repellant laminate; (2) coating linerboard with a michaelman coating, which is a wax-like substance; and (3) coating linerboard with wax. However, each of these methods adds significant production costs to the linerboard fabrication process and, ultimately, the corrugated fabrication process. For example, each of the above-listed processes requires the use of an on- or off-machine coating station. A coating station is a substantial and costly section of a paper machine requiring monitoring and maintenance. Further, the time the linerboard must spend running through the coating station is not insignificant and can noticeably reduce the paper mill's production per day compared to a production line that does not utilize a coating station.

Beyond production costs, the above-listed processes produce a

resultant moisture barrier product that is not completely repulpable and, in fact, is often rejected by recycling plants only to end up in a land fill. Moreover, the resultant moisture barrier product has a surface coating that can affect down-line production. For instance, the surface coating is often difficult to print on thereby requiring a special ink. The surface coating may also create problems in gluing portions of the corrugated to form a container; the glue not adhering well to the surface coating. The surface coating is easily scratched reducing the effectiveness of the moisture barrier protection. And, because the surface coating is just that, a *surface* coating instead of an individual fiber coating, it can become delaminated or separated from its underlying linerboard. This is a special concern in two-ply paper where two dry plies are laminated together by an intermediate moisture barrier coating; with three separate and distinct layers, little force is necessary to delaminate, or pull the plies apart from the moisture barrier coating.

Other attempts at producing moisture barrier products, have used wet-end processes. For example, U.S. Patent 3,560,334 describes a process in which a flocculant is added to a fiber suspension that is laid out on a moving web. A dispersant containing an additive, such as a water repellant additive, is then applied to the wet web such that the dispersant interacts with the flocculant and clumps together to form particles greater than the pore size of the web resulting in retention of the additive on the surface of the web. However, repulpability and quality of these types of resulting products are still a concern. For instance, some wet-end created moisture barrier products, upon repulping and/or recycling, result in linerboard that flakes or fluffs and as such, is not commercially viable.

Therefore, there is a need for a moisture barrier paper that can provide the level of moisture protection required while at the same time reduce production costs, increase corrugated quality aspects, and be repulpable.

SUMMARY OF THE INVENTION

In view of the above, a moisture barrier paper of the present invention comprises a fiber mat and a unique moisture barrier coating. The moisture barrier coating coats substantially every fiber throughout the fiber mat. The moisture barrier paper is created in a wet-end, on-machine process where a liquid, moisture barrier coating is sprayed onto a forming fiber mat and is drawn through the fibers with vacuum. The moisture barrier paper has top and bottom surfaces that are substantially free of wax and polymeric water repellants. The moisture barrier paper is completely repulpable.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic of a typical forming section of a paper machine. As shown, the forming section generally incorporates a fourdrinier, which is used in making a single-ply paper or board, and an optional top wire former, which is generally used to enhance the properties of a single-ply or in creating two-ply paper or board.

DESCRIPTION OF THE INVENTION

The below-described invention is detailed relative to the concept of a moisture barrier linerboard (basis weight 20 lb. to 66 lb.) that may ultimately be used in corrugated. However, without departing from the spirit or scope of the invention as described herein, the process is transferable to virtually any other grade of paper or board that has the goal of achieving a moisture barrier property.

Referring to Figure 1, a typical wet-end paper machine forming section is depicted. The forming section generally comprises a fourdrinier 10. A headbox 12 positioned at one end of fourdrinier 10 delivers a prepared slurry of paper-making fibers onto the fourdrinier's moving wire or fabric 14. A breast roll 16, generally considered the first element in a fourdrinier, is located under the headbox apron lip 13 and serves to feed wire 14 into the forming area of fourdrinier 10 in a flat and uniform

manner. The forming area of fourdrinier 10 comprises of a plurality of foil drainage boxes 18 and vacuum boxes 20. Drainage boxes 18 allow free water to drain away from the paper fibers while vacuum boxes 20 add additional suction to force removal of free water. The number of drainage boxes 18 and vacuum boxes 20 vary with the type of paper or board being made and are selected accordingly by the paper maker. Other drainage devices, such as table rolls and vacuum flatboxes, may also be incorporated into the forming section of fourdrinier 10 as appropriate. At the end of fourdrinier 10 opposite headbox 12 is located a suction couch roll 24. Suction couch roll 24 draws additional water from the now formed fiber mat prior to the fiber mats transfer to the press section (not shown). A wire turning roll 25 preferably drives the wire 14 while wire return rolls 26 preferably aid in the driving, guiding and tensioning of wire 14.

A forming section having only a fourdrinier is often used in the making of a single-ply paper or board. However, to enhance the single-ply's quality or to create a two-ply paper or board, a top wire former 30 is used. The presence of a second headbox 32 located relative to top wire former 30 provides indication that the top wire former 30 in FIG. 1 is used in creating a second ply. As with fourdrinier 10, headbox 32 delivers a prepared slurry of paper making fibers to a wire or fabric 31. A breast roll 33 serves to feed wire 31, and the slurry atop of it, into the forming section of top wire former 30. The forming section comprises a plurality of drainage boxes 34 and vacuum boxes 36 which are selected appropriately for the type of paper being made. As with fourdrinier 10, the number and types of drainage devices will vary with the type of paper or board. Top wire former 30 also incorporates a suction couch roll 38 that draws additional water from the now formed fiber mat. Top wire former 30 is preferably designed so that suction couch roll 38 may be pivoted or placed in contact with wire 14 of fourdrinier 10 to enable transfer of the top wire former's top ply fiber mat to the fourdrinier's bottom ply fiber mat. FIG.1 depicts one configuration of a top wire former, numerous other configurations of top wire formers are available and can be used in

conjunction with fourdrinier 10 without departing from the spirit or scope of the invention.

The liquid sprayer is used in the process of creating a moisture barrier linerboard and is designated as item 50. In creating a moisture barrier linerboard, liquid sprayer 50 is supplied with a liquid, moisture barrier coating material. The liquid, moisture barrier coating material is preferably a material incorporating the characteristics identified in Table 1.

TABLE 1

Characteristic	Desired Characteristic in Moisture Barrier Coating
pH	9.2-10.2
Percent Solids	38-52%
Viscosity	25-45 cps
Boiling Point	212° F/100° C
Melting Point	32° F/0° C
Freezing Point	32° F/0° C
Specific Gravity	1.02
Evaporation	Equal to Water
Vapor Density	less than 1
Solubility	Dispersable in Water
Odor	Somewhat Latex

The moisture barrier coating contains little, or no, wax or polymeric water-repellants. Further, the moisture barrier coating has no negative effect on, but rather is compatible with, the existing chemistry of the paper making process, e.g. the chemical composition of the slurry. A consequence of this compatibility is that the press felts remain free of any accumulating waxes, polymeric water repellants, or other like materials that eventually plug the press felt drainage holes. Any liquid coating having the above-described,

or similar characteristics, may be used without departing from the spirit or scope of the invention.

The process of making the moisture barrier paper begins with headbox 12 delivering a prepared slurry of paper-making fibers onto the fourdrinier's moving wire 14. Simultaneously, headbox 32 delivers a prepared slurry of paper-making fibers onto the top wire former's moving wire 31. At the time the slurry hits the wires 14, 31, it consists of approximately 99.5% water and 0.5% fiber. As the slurry progresses across the forming table of fourdrinier 10, drainage boxes 18 and vacuum suction boxes 20 remove free water. Similarly, the paper slurry on the top wire former 30 passes over drainage boxes 34 and vacuum boxes 38 where free water is also removed. Prior to the point at which the base sheet or bottom ply of fourdrinier 10 is joined with the top sheet or ply of top wire former 30, liquid sprayer 50 sprays the liquid, moisture barrier coating across the width of wire 14 onto the base sheet.

At the time the liquid, moisture barrier coating is sprayed onto the base sheet, the base sheet is a fiber mat preferably having a consistency of 8-24% fiber, and more preferably 15-18% fiber, with the remainder of the consistency comprising liquid or water. Spraying the liquid, moisture barrier coating prior to reaching the above-identified fiber percentages will result in dilution of the coating and weakening of the moisture barrier properties. The addition of the liquid, moisture barrier coating displaces a portion of the existing water and thus, substantially maintains the fiber percentage. After the liquid, moisture barrier coating has been sprayed onto the base sheet and while substantially maintaining the above-identified base sheet fiber percentages, the top sheet from top-wire former 30 is joined to the base sheet. At the time of joining, the top sheet is a fiber mat preferably having the consistency of 8-20% fiber, and more preferably 17-20% fiber, with the remainder of the consistency comprising liquid or water. The now existing two-ply sheet, or unitary fiber mat, continues to travel over the remaining length of the forming table of fourdrinier 10 for additional water removal. At the point where the two-ply sheet leaves

suction couch roll 24 and is transferred to the press section, the two-ply sheet preferably consists of 24-30% fiber with the remainder of the consistency comprising liquid or water.

Liquid sprayer 50 is preferably placed four to twelve inches above the base sheet and preferably delivers the liquid, moisture barrier coating in an undiluted state and containing 20-75% solids, more preferably 20-45% solids. Liquid sprayer 50 preferably applies the liquid, moisture barrier coating material at an angle of 90° to the base sheet however, other angles may be equally appropriate. After the liquid, moisture barrier coating is sprayed onto the base sheet, vacuum boxes 20 act to draw the liquid, moisture barrier coating down through the forming fiber mat such that substantially every fiber in the base sheet becomes coated. The top sheet is pressed by couch roll 38 into the bottom sheet and the liquid, moisture barrier coating enabling the top sheet to wick up the liquid, moisture barrier coating into its fibers. The actual amount of coating that is necessary for application varies with the paper grade and weight. A simple measure of whether enough liquid, moisture barrier coating is being applied is when the liquid, moisture barrier coating is noticeable in the liquid draining into the first drainage or vacuum box after the application point.

The resulting two-ply linerboard product has a unique moisture barrier that is unitary to the linerboard and its fibers. To achieve the best unitary moisture barrier, it has been determined that 60% of the overall basis weight of the sheet should be maintained in the bottom sheet while the remaining 40% should be maintained in the top sheet. However, a ratio of bottom sheet to top sheet may vary anywhere between 80/20 and 50/50 and still produce a resulting two-ply sheet with desirable moisture barrier properties. Because the moisture barrier coating is not a surface coating and because the unitary moisture barrier contains little, or no, waxes and/or polymeric water repellants, the resultant linerboard is easily printed on with standard inks and is easily glued.

Further, the resultant two-ply, moisture barrier, linerboard product

is able to achieve a water vapor transmission rate (WVTR), as determined by the Technical Association of the Pulp and Paper Industry (TAPPI) Test Method T 448 om-89, which is hereby incorporated by reference, of less than 1. WVTR of a sheet material is defined as the mass of water vapor transmitted per unit time per unit area from face of the sheet to the other under specified steady conditions. The standard unit of WVTR is g/100 in^2/day. Actual results of Test Method T448 performed on five samples of 33 pound, moisture barrier linerboard product may be found in Table 2.

TABLE 2

33# Moisture Barrier Sample	WVTR g/100 in^2/day
1	0.51
2	0.76
3	0.58
4	0.61
5	0.13

The WVTR of an uncreased sheet of the moisture barrier linerboard is comparable to that of a two-ply linerboard created by laminating two dry sheets to a surface coating while the WVTR of a creased sheet of the moisture barrier linerboard far surpasses the WVTR of a two-ply linerboard created by laminating two dry sheets to a surface coating. In the case of a creased, two-ply linerboard with intermediate surface coating, moisture is able to seep under the crack in the surface coating made by the crease and destroy the moisture barrier. No such cracks can occur in the linerboard with the unitary moisture barrier. The linerboard with unitary moisture barrier measures substantially the same WVTR whether tested on its top or bottom surface. Linerboard that is simply surface coated cannot provide the same results.

Additionally, the resultant two-ply, linerboard product with unitary

moisture barrier is considerably stronger than that of a two-ply linerboard created by laminating two dry sheets to a surface coating and can be of a considerably less basis weight. For instance, a 56 pound basis weight, two-ply linerboard with laminated, intermediate surface coating, is appropriately replaced with a 26 pound, basis weight, two-ply linerboard with unitary moisture barrier coating. Such a 26 pound, basis weight linerboard requires approximately 320 pounds of force to pull it apart.

Other advantages of the two-ply linerboard with unitary moisture barrier include the fact that the linerboard can be created completely on-machine, eliminating the need for an on- or off-machine coating station. Further, the liquid, moisture barrier coating requires no alteration in existing machine chemistries. For instance, if the slurry includes a starch or colored dye, the chemical formulation of the starch or colored dye need not be altered to accommodate the liquid, moisture barrier coating.

Use of the liquid, moisture barrier coating also produces a linerboard that is completely repulpable as determined by American Forest Products Association/Fiber Box Association's "Voluntary Standard for Repulping and Recycling Corrugated Fiberboard Treated to Improve its Performance in the Presence of Water and Water Vapor". This voluntary standard is hereby incorporated by reference. The repulpability portion of this standard determines the repulpability of treated corrugated by determining fiber-on-fiber yield (the amount of fiber, which remains after a processing action, expressed as a percentage of the fiber present in the material to be tested). The repulpability test method for the voluntary standard may be described in general terms as follows:

> A 100% charge of treated corrugated is repulped in a British Disintegrator in artificially hardened water at a pH of 7 (±0.5 pH) that is maintained at 135° (±5°) for 45,000 cycles. The pulped material is separated in a screen with 0.010 inch slots to determine fiber recovery as a percentage of the amount of fiber charged. The amount of coating material deposited on a

coupon in the disintegrator is used to measure treatment deposition during repulping.

Actual testing of corrugated treated with the liquid moisture barrier coating of the present invention produced a repulping yield of 94.1% and a deposition of 0.0 mg. The test also noted that no equipment deposition or other adverse effect was noted during repulping and screening. As such, the test material easily passed the repulping voluntary standard.

Further, when the liquid, moisture barrier coating is allowed to cure, e.g. the linerboard is allowed to rest for approximately forty-eight hours prior to additional processing such as fabricating into corrugated, printing, or gluing, moisture barrier properties are increased. However, the linerboard may be processed immediately, without additional curing, and provide significant moisture barrier protection.

A single-ply paper may be created using the process described above but with elimination of the top wire former and its related considerations.

The present invention may be embodied in other specific forms without departing from the spirit of the essential attributes thereof; therefore, the illustrated embodiment should be considered in all respects as illustrative and not restrictive, reference being made to the appended claims rather than to the foregoing description to indicate the scope of the invention.

WHAT IS CLAIMED:

1. A moisture barrier pulp product, comprising:

at least one ply of a fiber mat, said fiber mat comprising a plurality of top surface fibers, a plurality of bottom surface fibers and a plurality of intermediate fibers, said plurality of intermediate fibers intermediate and unitarily joined to said plurality of top surface fibers and bottom surface fibers, and wherein a substantial portion of said plurality of top surface fibers, said plurality of bottom surface fibers and said plurality of intermediate fibers are unitary with a moisture barrier coating.

2. The moisture barrier pulp product of claim 1, wherein said moisture barrier coating is substantially wax free.

3. The moisture barrier pulp product of claim 1, wherein said moisture barrier coating is substantially free of polymeric water-repellants.

4. The moisture barrier pulp product of claim 1, wherein said at least one ply of a fiber mat with said moisture barrier coating has a water vapor transmission rate of less than 5.

5. The moisture barrier pulp product of claim 1, wherein said at least one ply of a fiber mat with said moisture barrier coating has a water vapor transmission rate of less than 1.

6. The moisture barrier pulp product of claim 1, said moisture barrier pulp product further comprising at least two plies of fiber mats.

7. The moisture barrier pulp product of claim 1, wherein said at least one ply of a fiber mat with said moisture barrier coating is completely repulpable.

8. The moisture barrier pulp product of claim 1, wherein said moisture barrier pulp product comprises a linerboard pulp product.

9. A moisture barrier pulp product, comprising:

at least two plies of fiber mats, wherein the fibers of said at least two plies of fiber mats are unitarily joined such that the joined fiber mats comprise a plurality of top surface fibers, a plurality of bottom surface fibers and a plurality of intermediate fibers, said intermediate fibers intermediate to and unitarily joined to said plurality of top surface fibers and bottom surface fibers, and wherein a substantial portion of said top surface fibers, said plurality of bottom surface fibers and said plurality of intermediate fibers are unitary with a moisture barrier coating.

10. The moisture barrier pulp product of claim 9, wherein said at least two plies of fiber mats comprise a top fiber mat and a bottom fiber mat, and wherein said bottom fiber mat comprises in the range of 50% to 80% of a basis weight of the moisture barrier pulp product and said top fiber mat comprises 20% to 50% of said basis weight of the moisture barrier pulp product.

11. The moisture barrier pulp product of claim 10, wherein said bottom fiber mat comprises approximately 60% of the basis weight of the moisture barrier pulp product and said top mat comprises approximately 40% of the basis weight of the moisture barrier pulp product.

12. The moisture barrier pulp product of claim 9, wherein said moisture barrier coating is substantially wax free.

13. The moisture barrier pulp product of claim 9, wherein said moisture barrier coating is substantially free of polymeric water repellants.

14. The moisture barrier pulp product of claim 9, wherein said at least two plies of fiber mats with said moisture barrier coating has a water vapor transmission rate of less than 5.

15. The moisture barrier pulp product of claim 9, wherein said at least two plies of fiber mats with said moisture barrier coating is completely repulpable.

16. The moisture barrier pulp product of claim 9, wherein said moisture barrier pulp product comprises a linerboard pulp product.

17. A process for making a moisture barrier pulp product, comprising the steps of:

depositing a slurry of paper-making fibers and liquid onto a moving wire;

draining a portion of the liquid from the slurry to form a fiber mat;

spraying said fiber mat with a liquid, moisture barrier coating; and

applying suction to said fiber mat to draw said liquid, moisture barrier coating through the fibers of said fiber mat.

18. The process of claim 17, wherein said liquid, moisture barrier coating is substantially wax free.

19. The process of claim 17, wherein said liquid, moisture barrier coating is substantially free of polymeric water repellants.

20. The process of claim 17, wherein said step of draining comprises draining a portion of the liquid from the slurry to form a fiber mat having a consistency in the range of 8% to 24% fibers and 76% to 92% liquid.

21. The process of claim 17, wherein said step of draining comprises draining a portion of the liquid from the slurry to form a fiber mat having a consistency in the range of 15% to 18% fibers and 82% to 85% liquid.

22. The process of claim 17, wherein said step of applying suction to said fiber mat further comprises applying suction to said fiber mat to produce a fiber mat having a consistency in the range of 24% to 30% fibers and 70% to 76% liquid.

23. The process of claim 17, wherein said step of applying suction to said fiber mat to draw said liquid, moisture barrier coating through the fibers of said fiber mat further comprises drawing said liquid, moisture barrier coating through the fibers to coat substantially every fiber in said fiber mat with said liquid, moisture barrier coating.

24. A process for making a moisture barrier pulp product, comprising the steps of:

depositing a slurry of paper-making fibers and liquid onto a first moving wire;

depositing a slurry of paper-making fibers and liquid onto a second moving wire;

draining a portion of the liquid from the slurry on the first moving wire to form a base fiber mat;

draining a portion of the liquid from the slurry on the second moving wire to form a top fiber mat;

spraying said base fiber mat with a liquid, moisture barrier coating after said step of draining;

joining said top fiber mat to said base fiber mat to form a unitary fiber mat after said step of spraying; and

applying suction to said unitary fiber mat to draw said liquid, moisture barrier coating through the fibers of said unitary fiber mat.

25. The process of claim 24, wherein the step of joining comprises pressing said top fiber mat to said base fiber mat.

26. The process of claim 24, the step of joining said top fiber mat to said base fiber mat to form a unitary fiber mat after spraying, wherein the fibers of said top fiber mat are adapted to wick up a portion of said liquid, moisture barrier coating.

27. The process of claim 24, wherein said liquid, moisture barrier coating is substantially wax free.

28. The process of claim 24, wherein said liquid, moisture barrier coating is substantially free of polymeric water repellants.

29. The process of claim 24, wherein the step of draining to form a base fiber mat comprises draining a portion of the liquid from the slurry on the first moving wire to form a base fiber mat having a consistency in the range of 8% to 24% fibers and 76% to 92% liquid.

30. The process of claim 24, wherein the step of draining to form a base fiber mat comprises draining a portion of the liquid from the slurry on the first moving wire to form a base fiber mat having a consistency in the range of 15% to 18% fibers and 82% to 85% liquid.

31. The process of claim 24, wherein the step of draining to form a top fiber mat comprises draining a portion of the liquid from the slurry on the second moving wire to form a top fiber mat having a consistency in the range of 8% to 20% fibers and 80% to 92% liquid.

32. The process of claim 24, wherein the step of draining to form a top fiber mat comprises draining a portion of the liquid from the slurry on the second moving wire to form a top fiber mat having a consistency in the

range of 17% to 20% fiber and 80% to 83% liquid.

33. The process of claim 24, wherein said step of applying suction to said unitary fiber mat to draw said liquid, moisture barrier coating through the fibers of said unitary fiber mat further comprises drawing said liquid, moisture barrier coating through the fibers to coat substantially every fiber in said unitary fiber mat with said liquid, moisture barrier coating.

34. The process of claim 24, wherein said base fiber mat comprises in the range of 50% to 80% of a basis weight of the moisture barrier pulp product and said top fiber mat comprises 20% to 50% or said basis weight of the moisture barrier pulp product.

35. The process of claim 24, wherein said base fiber mat comprises approximately 60% of a basis weight of the moisture barrier pulp product and said top fiber mat comprises approximately 40% of the basis weight of the moisture barrier pulp product.

36. The process of claim 24, wherein said moisture barrier pulp product is a moisture barrier linerboard pulp product.

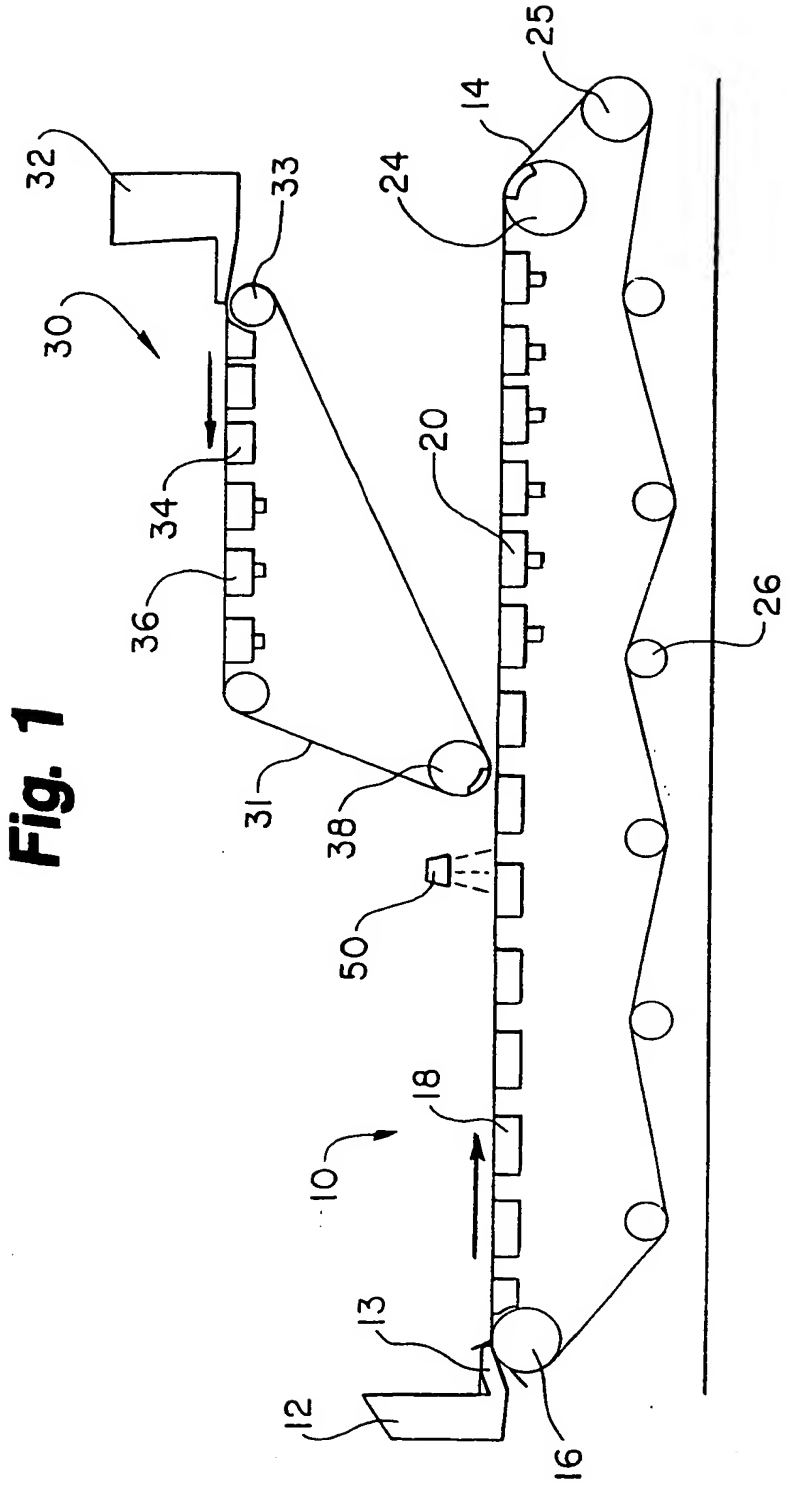

Fig. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/25097

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :D21H 17/20, 17/37, 23/26; B05D 3/04, 3/12; D21C 5/02

US CL :Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 162/4, 5, 60, 123, 125, 129, 135, 137, 158, 163, 164.1, 168.1, 168.3; 427/358, 361, 366, 391, 428; 428/339, 348, 349

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, DIALOG, WEST
(water or moisture) barrier, water repellen?, water-proof, water resistan?, papermaking, spray?, coat?

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,429,294 A (PROPST) 04 July 1995, see entire document.	1-36
X	US 4,510,019 A (BARTELLONI) 09 April, 1985, see columns 5-13.	1-36
X	US 5,531,863 A (PROPST) 02 July 1996, see entire document.	1-36
X,E	US 5,858,173 A (PROPST, JR.) 12 January 1999, see entire document.	1-36
Y	US 5,626,945 A (BERZINS et al.) 06 May 1997, see whole document.	1, 4-11, 14-17, 20-26, and 29-36

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
24 FEBRUARY 1999	15 APR 1999

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/25097

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,635,279 A (MA et al) 03 January 1997, see whole document.	1, 4-11, 14-17, 20-26, and 29-36
A	US 5,603,997 A (LINDGREN et al) 18 February 1997, see entire document.	1-36

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/25097

A. CLASSIFICATION OF SUBJECT MATTER:
US CL : .

162/4, 5, 60, 123, 125, 129, 135, 137, 158, 163, 164.1, 168.1, 168.3; 427/358, 361, 366, 391, 428; 428/339, 348, 349